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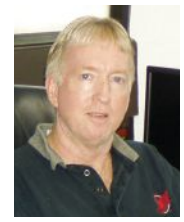

Large fans can be challenging

Your new world-class facility has just started up. As the maintenance manager of the facility, your group is in charge of the rotating equipment. Your group has been fighting the typical start-up battle and headway is being made. In your morning meeting, there is one item that shows up on the radar as the next battle for your team. The vibration fan's vibration is outside acceptable limits. The 3,000-horsepower driver and fan design make the fan a big one. There are two fans running in parallel. The second fan serves as a backup, but the system is designed to run in parallel.

During planned outages that frequently occur on commissioning, the OEM has sent a team to assess the problem. The team has found nothing wrong. You decide to put a root cause analysis team together to attack the problem.

When looking at fans, key areas to consider include but are not limited to:

1. Fan performance analysis. One key point is to determine whether the fan is meeting its performance requirements. Typically, a factory acceptance test (FAT) is performed to validate the fan is fit for its purpose in the field. However, more often than not, the FAT doesn't duplicate actual field conditions. Historically, the inlet and outlet ducting systems are less favorable to the FAT test. For large fans, there may be inlet temperature gradients that affect actual performance. The FAT test doesn't include any interaction effects with spare fans or fans operating in parallel that could affect performance. One of the major issues with the fan performance analysis is converting the data to standard conditions most often listed in flow as million standard cubic feet per hour. The FAT test fan curves are validated or generated to serve as a basis for performance and design. The performance curves are also based on standard temperature conditions. Sometimes, the fans have cooled bearings. Also, field conditions run at a temperature higher than standard. These conditions can affect the actual rotor dynamics response.

2. Field study. A field study should be conducted and thermal imaging of inlet/outlet ducting systems, the bearings and the fan should be done to determine if there are operating thermal gradients present. Field data should be acquired from the bearings, the inlet and outlet dynamic pressures, and structural vibration. In some cases, acoustic transducers should be put on the inlet/outlet ducting and fan casing. One of the major considerations in the field study is the movement and vibration of the pedestal supports. During design, the supports are usually considered rigid but, in reality, they are not.

3. Fan balance. Many fans are balanced in the shop and sent to the field. Shipping, painting and other work done could affect the fan balance. The best way to handle the situation is to balance the fan in the field. Field balancing takes into account any residual differences between the shop mount and field mount.

4. Aerodynamics. A computational fluid dynamics study should be conducted for the inlet and outlet fan ducting. This is especially important if the fan is not meeting design conditions. The model should be detailed enough to consider wake separation effects off the blades and any vane flow separation that could cause system excitation. Since these two fans are in parallel, the interaction effect should be considered in the model.

5. Finite element analysis (FEA). FEA heat transfer models for the fan should be conducted to determine whether the shaft is bowing and what the expected temperatures for the rotating elements are. The FEA should be compared to any thermal imaging. Structural analysis should be conducted to evaluate system movement.

6. Rotor dynamics. Rotor dynamics is one of the most important aspects when troubleshooting. Evaluations should be conducted to look at transient and steady state conditions. The actual stiffness of the pedestals should be incorporated into the rotor dynamics model.

7. Root cause analysis. A root cause analysis should be conducted to consider all that was done above.

Rotating equipment problems should be supervised by qualified professional engineers who have expertise with this type of equipment.

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